CLAIMS

What is claimed is:

1. A method of detecting deflection and twisting rotation of an upright structure comprising:

(a) positioning at least one laser device proximate to a first location on the structure;

(b) positioning at least one target proximate to a second location on the structure;

(c) emitting at least two parallel laser beams from the at least one laser device and striking the at least one target at reference locations that indicate a reference position for the upright structure; and

(d) monitoring any change in position of the points where the laser beams strike the at least one target and calculating any differences between the points and the reference locations to determine any lateral deflection and twisting rotation of the structure relative to the reference position from the first to the second location.

2. The method of claim 1, wherein the parallel laser beams are emitted continuously.

3. The method of claim 1, wherein the upright structure is a tower.

4. The method of claim 1, wherein the at least one laser device is disposed at or near a base of the structure and the at least one target is disposed at or near a top of the structure.

5. The method of claim 1, wherein step (d) comprises focusing at least one camera at the at least one target and analyzing the differences with at least one image analyzing computer.

11. The method of claim 10, wherein a tube is mounted from the first to the second module, and the laser beam from the laser passes through the tube.

12. The method of claim 10, wherein one of the modules is at or near a base of the upright structure and the other of the modules is at or near a top of the upright structure.

13. The method of claim 10, wherein the first module is disposed at or near the base of the upright structure and the second module is disposed at or near an upper end of the upright structure.

14. The method of claim 10, wherein any movement of the laser beam on the target is discerned by using a camera focused on the target, the camera being located adjacent the target and offset from the laser beam.

15. The method of claim 10, wherein the target comprises a pixel grid and any movement of the laser beam on the target is discerned by using a pixel element analyzing computer.

16. The method of claim 10, wherein the reference location corresponds to zero deflection of the upright structure.

17. An apparatus for detecting lateral deflection and twisting rotation of an upright structure comprising:

at least one first module adapted to be mounted adjacent a first location of the structure;

at least one second module spaced a distance from the at least one first module and adapted to be mounted adjacent a second location of the structure;

a laser emitter disposed at the at least one first module, the emitter capable of emitting at least one laser beam;

a target disposed on the at least one second module, the target being capable of receiving the at least one laser beam produced by the emitter; and

a detection device that detects any differences between the locations of a plurality of parallel laser beams that strike the target at any time and predetermined reference locations on the target to determine any deflection and rotation of the first location of the upright structure relative to the second location of the upright structure.

18. The apparatus of claim 17, wherein the emitter is capable of emitting a plurality of parallel laser beams.

19. The apparatus of claim 17, wherein the upright structure is a tower, and the first and second locations are substantially fixed relative to each other.

20. The apparatus of claim 17, further comprising at least one tube extending between the at least one first and second modules for enclosing the laser beams.

21. The apparatus of claim 17, wherein the detection device comprises a camera mounted adjacent to the target such that a line extending from a lens of the camera to the target is at an inclination relative to the laser beams.

22. The apparatus of claim 17, wherein the target comprises a pixel grid.

23. A tower, comprising:

an elongated structure having a base and a top;

at least one laser device disposed at a first location on the structure;

at least one target disposed at a second location on the structure for receiving a laser beam from the at least one laser device;

a detection device that monitors the at least one target to determine any change in position of where the laser beam strikes the at least one target, thereby indicating deflection of the tower.

24. The apparatus of claim 23, wherein at least one tube extends from the at least one laser device to the at least one target.

25. The apparatus of claim 23, wherein the detection device comprises a camera mounted adjacent to the target such that a line extending from a lens of the camera to the target is at an inclination relative to the laser beams.

26. The apparatus of claim 23, wherein the target comprises a pixel grid.

6. The method of claim 1, wherein step (b) comprises providing the at least one target with a pixel grid and step (c) comprises striking the pixel grid with the laser beams.

7. The method of claim 1, further comprising mounting at least one tube between the first location and the second location, and step (c) comprises emitting the laser beams through the at least one tube.

8. The method of claim 1, wherein step (a) comprises stationarily mounting the at least one laser device relative to the first location and step (b) comprises stationarily mounting the at least one target relative to the second location.

9. The method of claim 1, wherein the reference position of the tower is substantially zero deflection and zero twist rotation.

10. A method of measuring deflection of an upright structure comprising:

positioning a first module proximate to a first location on the structure, the first module having at least one laser;

positioning a second module proximate to a second location on the structure, the second module having a target;

emitting a laser beam from the laser which strikes a reference location on the target;

continuing to emit the laser beam and discerning any movement of the laser beam on the target relative to the reference location; and

calculating the amount of deflection of the structure based upon any differences in movement.

11. The method of claim 10, wherein a tube is mounted from the first to the second module, and the laser beam from the laser passes through the tube.

12. The method of claim 10, wherein one of the modules is at or near a base of the upright structure and the other of the modules is at or near a top of the upright structure.

13. The method of claim 10, wherein the first module is disposed at or near the base of the upright structure and the second module is disposed at or near an upper end of the upright structure.

14. The method of claim 10, wherein any movement of the laser beam on the target is discerned by using a camera focused on the target, the camera being located adjacent the target and offset from the laser beam.

15. The method of claim 10, wherein the target comprises a pixel grid and any movement of the laser beam on the target is discerned by using a pixel element analyzing computer.

16. The method of claim 10, wherein the reference location corresponds to zero deflection of the upright structure.

17. An apparatus for detecting lateral deflection and twisting rotation of an upright structure comprising:

at least one first module adapted to be mounted adjacent a first location of the structure;

at least one second module spaced a distance from the at least one first module and adapted to be mounted adjacent a second location of the structure;

a laser emitter disposed at the at least one first module, the emitter capable of emitting at least one laser beam;

a target disposed on the at least one second module, the target being capable of receiving the at least one laser beam produced by the emitter; and

a detection device that detects any differences between the locations of a plurality of parallel laser beams that strike the target at any time and predetermined reference locations on the target to determine any deflection and rotation of the first location of the upright structure relative to the second location of the upright structure.

18. The apparatus of claim 17, wherein the emitter is capable of emitting a plurality of parallel laser beams.

19. The apparatus of claim 17, wherein the upright structure is a tower, and the first and second locations are substantially fixed relative to each other.

20. The apparatus of claim 17, further comprising at least one tube extending between the at least one first and second modules for enclosing the laser beams.

21. The apparatus of claim 17, wherein the detection device comprises a camera mounted adjacent to the target such that a line extending from a lens of the camera to the target is at an inclination relative to the laser beams.

22. The apparatus of claim 17, wherein the target comprises a pixel grid.

23. A tower, comprising:

an elongated structure having a base and a top;

at least one laser device disposed at a first location on the structure;

at least one target disposed at a second location on the structure for receiving a laser beam from the at least one laser device;

a detection device that monitors the at least one target to determine any change in position of where the laser beam strikes the at least one target, thereby indicating deflection of the tower.

24. The apparatus of claim 23, wherein at least one tube extends from the at least one laser device to the at least one target.

25. The apparatus of claim 23, wherein the detection device comprises a camera mounted adjacent to the target such that a line extending from a lens of the camera to the target is at an inclination relative to the laser beams.

26. The apparatus of claim 23, wherein the target comprises a pixel grid.